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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/632,873	08/01/2003	Yunsang Kim	007354	4644
			ALRT/ETCH/DRIE	
			EXAMINER	
			GEORGE, PATRICIA ANN	
			ART UNIT	PAPER NUMBER
			1765	
DATE MAILED: 07/13/2005				

44182 7590 07/13/2005

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/632,873

Applicant(s)

KIM ET AL.

Examiner

Patricia A. George

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 August 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) 14-20 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☒ Claim(s) 1-20 are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 01 August 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 8/1/03 & 5/19/05
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Election/Restrictions

Restriction to one of the following inventions is required under 35 USC 121:

- I. Claims 1-13, are drawn to a plasma etch process for selectively etching a layer of low-k dielectric material, classified in class 438, subclass 710.
- II. Claims 14-16, are drawn to a computer readable medium, classified in class 700, subclass 90+.
- III. Claims 17-20, are drawn to a method for creating damascene or dual damascene structures, classified in class 438, subclass 618.

The inventions are distinct, each from the other because of the following reason:

Inventions I and II are related as process and product. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the product as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case invention I, the plasma etch process, could be stored on the CPU of an etcher and invention II, the computer readable medium, could store an electronic file of a photograph.

Inventions I and III are related as combination and subcombination. Inventions in this relationship are distinct if it can be shown that (1) the combination as claimed does not require the particulars of the subcombination as claimed for patentability, and (2) that the subcombination has utility by itself or in other combinations (MPEP §

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806.05(c)). In the instant case, the combination as claimed does not require the particulars of the subcombination as claimed because the etch process may be used in etching the low K dielectric layer without having carbon. The subcombination has separate utility such as the etch process may be used to make a dual damascene.

Inventions II and III are unrelated. Inventions are unrelated if it can be shown that they are not disclosed as capable of use together and they have different modes of operation, different functions, or different effects (MPEP § 806.04, MPEP § 808.01). In the instant case the different inventions. The inventions are unrelated because invention II is drawn to a computer readable medium whereas invention III is drawn to a method for making damascene or dual damascene structures.

During a telephone conversation with Keith Tobada on May 24, 2005 a provisional election was made without traverse to prosecute the invention of application number 10/632873, claims 1-13. Affirmation of this election must be made by applicant in replying to this Office action. Claims 14-16, and 17-20 were withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-13 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The following language in claim 1 is not clear: "comprising a fluorine-rich fluorocarbon or hydrofluorocarbon gas, a nitrogen-containing gas, and a hydrogen-rich hydrofluorocarbon gas." The claim could be interpreted to include anywhere from one (1) to three (3) additives. Is it the intent to select *at least one from a group consisting of a fluorine-rich fluorocarbon, and hydrofluorocarbon gas, in addition to both a nitrogen-containing gas, and a hydrogen-rich hydrofluorocarbon gas?* The examiner has interpreted this claim to include *at least one from a group consisting of a fluorine-rich fluorocarbon, and hydrofluorocarbon gas, in addition to both a nitrogen-containing gas, and a hydrogen-rich hydrofluorocarbon gas.* Please note the use of Markush group language.

Claims 2-13 are indefinite because they directly or indirectly depend on claim 1.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-2, 4-6, 9, and 12 are rejected under 35 U.S.C. 102(e) as being anticipated by Desphande et al (US Patent No. 6,869,542).

Desphande discloses a plasma etch process (col. 8, line 23) for selectively etching (col. 4, line 63) a layer of low-k dielectric material having a dielectric constant less than 4 (line 63, silicon dioxide has dielectric constant of 3.9), comprising: Introducing into a plasma etch chamber (see col. 11, lines 36-37, then 60-61), in which the layer of low-k dielectric material is situated (67), an etching gas mixture (col. 12, line 27) comprising a fluorine-rich fluorocarbon (line 29) or hydrofluorocarbon gas (line 29), a nitrogen-containing gas (line 28), and a hydrogen-rich hydrofluorocarbon gas (line 29); and maintaining a plasma of the etching gas mixture (line 46) in the plasma etch chamber (line 47) to etch (line 45) the layer of low-k dielectric material (line 45).

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As for claim 2, Desphande discloses the fluorine-rich fluorocarbon gas is CF₄ (col. 12, line 29), the nitrogen-containing gas is N₂ (line 28), and the hydrogen-rich hydrofluorocarbon gas is selected from the group consisting of CH₂F₂ (line 29), CH₃F (line 29), and mixtures thereof (line 29).

As for claim 4, Desphande discloses the fluorine-rich fluorocarbon or hydrofluorocarbon gas is selected from the group consisting of CF₄, C₂F₆, CHF₃ (col. 12, line 29), and mixtures thereof (line 29).

As for claim 5, Desphande discloses a nitrogen-containing gas: N₂ (col. 12, line 28).

As for claim 6, Desphande discloses hydrogen-rich hydrofluorocarbon gases: CH₂F₂ (col. 12, line 29), CH₃F (line 29), and mixtures thereof (line 29).

As to claim 9, Desphande discloses a layer of low-k dielectric material that is: over a substrate (col. 9, lines 48-50), placed on a pedestal (see col. 11, line 67 to col. 12 line 1), in a plasma etch chamber (see col. 11, lines 36-37, then 60-61), that is maintaining a plasma of etching gas mixture (col. 12, line 27), comprising capacitively coupling (col. 6, lines 45-48) RF power into the plasma etch chamber, such that a substantial DC bias exists between the pedestal and the plasma (the limitation is written on in col. 8, lines 37-38 "500 Volts to 3000 Volts bias on the wafer" is used to refer to a bias in the same area).

As to claim 12 Desphande discloses the etching gas mixture (col. 12. line 27) comprises an inert gas (written on the limitation in line 31, "a noble dilutant" used to reference the same) selected from the group consisting of argon (col. 12, line 31), helium (line 31), neon, xenon, and krypton.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Claims 10, and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Desphande (see discussion above) in view of Hoffman et al (US Patent No. 6,894,245).

Desphande failed to teach the following configuration of claim 10: applying a bias power to the pedestal; and applying a source power to a top electrode facing the pedestal, wherein the source power has a frequency higher than a frequency of the bias power. Desphande also failed to teach a slowly rotating magnetic field in the chamber, as in claim 11.

As for claim 10, Hoffman teaches applying a bias power to the pedestal (col. 14, line 67) and applying a source power to a top electrode facing the pedestal (col. 3, lines 61-63). Hoffman teaches the frequency of the bias power is typically 13.56 MHz (col.

13, lines 40-43); significantly lower than the source power of 210 MHz taught in an “exemplary embodiment” (col. 4-5, lines 66-67 and 1-3).

As for claim 11, Hoffman teaches “the reactor further includes a set of MERIE magnets surrounding the plasma process area overlying the wafer surface that produce a slowly circulating magnetic field which stirs the plasma to improve plasma ion density distribution uniformity” (col. 2, line 61-66).

It would have been obvious to one ordinary skill in the art at the time of invention was made, to modify Desphande’s plasma etch process to include Hoffman’s MERIE system processing parameters because Desphande discloses the use of the MERIE reactor (col. 11, lines 61-62) as an example of a commercially available plasma etch chamber suitable for use in his process (see line 60 a continuation of the listing starting on lines 36-40).

Claim Rejections - 35 USC § 103

Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Desphande (see discussion above) in view of Su et al (US Patent No. 6,828,251) in further view of Becker et al (US Patent No. 6,287,978).

Desphande failed to teach the specific gas mixtures and associated volumetric flow rates and ratios thereof as in claim 7. Desphande also failed to teach the combination of same as in claim 8.

Su teaches several aspects of the claimed invention including all the features of the base claim. Su teaches on the limitation the etching gas mixture is introduced into the plasma etch chamber in col. 3-4, lines 67, and 1-3 “providing an ambient

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conductive to forming a plasma including at least nitrogen and at least one compound selected from the group consisting of fluorocarbons and hydrofluorocarbons”.

Su also teaches by that introducing the fluorine-rich fluorocarbon or hydrofluorocarbon gas at a first volumetric flow rate [(20-100 sccm) col. 4, line 20], the nitrogen-containing gas at a second volumetric flow rate [(50-300sccm) col. 4, lines 21-22]. Su teaches ranges sufficient to vary so that the ratio of the second volumetric flow rate to the first volumetric flow rate is about 1:4 to 2:1.

Although Su teaches the presence of hydrogen-rich hydrofluorocarbon gas, Su is silent as to the volumetric rate (col. 4, line 2-18).

Becker teaches selective etching of a silicon dioxide layer (col.1, line 17-18) where 14 sccm of CH₂F₂ are added (col. 7, line 25-26). Becker also teaches ranges sufficient to vary so that the ratio of the third volumetric flow rate to the first volumetric flow rate is about 1:3 to 1:1.

It would have been obvious to one ordinary skill in the art at the time of invention was made, to modify Desphande's plasma etch process to include volumetric flow rates and ratio as taught by Su and Becker because the volumetric flow ratios of the different gases in the process gas can also be tailored for different combinations of materials and to achieve specific etching selectivities, etch rates, or feature geometry without deviating from the scope of the present invention.

Claim Rejections - 35 USC § 103

Claims 3, and 13, are rejected under 35 U.S.C. 103(a) as being unpatentable over Desphande (see discussion above) in view of Su (see discussion above) in further view of Liu et al (US Patent No. 6,451,703).

Desphande and Su failed to teach a specific etch rate of low-k dielectric layer at higher than about 4000 .ANG./min, as in claim 3. Desphande and Su also failed to teach the specific combinations and ratios of said mixtures of claim 13.

As for claim 13, Liu further teaches etching TEOS, a low-K dielectric material, with an etch rate of 0.65-0.7um/min, which converts to 6500 ANG to 7000 ANG/min (col. 10, l. 7-9), which is within the cited range of higher than about 4000 ANG/min.

As for claim 13, Liu further teaches an oxide etch process where the ratio of the inert (second volumetric flow rate) to the fluorine-rich fluorocarbon (first volumetric flow rate) should be at least 20:1 (col. 9, lines 1-5).

It would have been obvious to one ordinary skill in the art at the time of invention was made, to modify Desphande's plasma etch process to include Liu's ratio of high inert gas because the volumetric flow ratios of the different gases in the process gas can be tailored for different combinations of materials and to achieve specific etching selectivities, etch rates, or feature geometry without deviating from the scope of the present invention.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

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US Patent No. 6,410,451 teaches Techniques for Improving Etching in a Plasma Processing Chamber. The CF:O₂ ratio is well defined. An etching chemistry of C_xF_y, along with oxidizer (O₂) is used to etch low-K dielectrics.

US Patent No. 6,090,403 teaches an effective reduction of micro loading with a combination of C₄F_x, N₂, and Ar for plasma etching dielectric materials.

US Patent No. 6,362,109 teaches Oxide/Nitride Etching having high selectivity to p-gates. The etchant includes fluorocarbon, difluoromethane, oxygen, and carbon monoxide for etching low-K dielectric materials.

US Patent No. 6,014,943, TEL Diapole Ring Magnetron (DRM) Unity DRM teaches many of the claimed aspects of the instant invention.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Patricia A. George whose telephone number is (571) 272-5955. The examiner can normally be reached on weekdays between 7:30am to 4:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


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NADINE G. NORTON
SUPERVISORY PATENT EXAMINER

